FLAMELESS PAVEMENT REPAIR SYSTEM

RELATED APPLICATIONS:

This application claims the benefit of U.S. Provisional Application No. 60/421,953 filed October 29, 2002 entitled *Flameless Pothole Patcher*.

TECHNICAL FIELD OF THE INVENTION

The present invention relates in general to paving systems and more particularly to a flameless pavement repair system and method of use thereof.

BACKGROUND OF THE INVENTION

Pothole repairs made with hot mix that is not maintained at a proper temperature produce repairs are short-lived and often require repeated applications. In order to maintain hot mix asphalt at a desired temperature, existing portable pavement repair systems typically use heat transfer oil that is heated by a propane burner to heat the hot mix asphalt during operation of the vehicle. When the vehicle is not in operation, existing systems may use an electric heat source powered by an external power source, such as an external electrical power outlet.

Current heating systems used with pavement repair systems have a number of significant drawbacks. For instance, the use of a propane burner requires that a pavement repair system carry a supply of propane or other fuel and the use of a flame-based heat source may present safety concerns. Additionally the inclusion of a second heating system for heating the hot-mix asphalt during non-operation periods (such as overnight) adds to the overall cost of the system.

SUMMARY OF THE INVENTION

Therefore a need has arisen for a pavement repair system for use with hot mix asphalt that does not require a flame-based heating system.

In accordance with teachings of the present disclosure, a system and method are described for a flameless pavement repair system that eliminates many of the problems associated with previous pavement repair systems and methods.

In one aspect a pavement repair system is disclosed that include a vehicle with a hopper. One or more flameless heating elements are installed adjacent the hopper to maintain materials in the hopper within a selected temperature range. The pavement repair system also includes an on-board generator that is powered by the vehicle and provides sufficient power to the electric heating element during vehicle operation to heat materials in the hopper.

In another aspect a hopper assembly for providing hot-mix asphalt in a pavement repair vehicle includes a hopper body and one or more flameless heating elements installed adjacent the hopper body and sized to heat hot mix asphalt materials within a desired temperature range. The flameless heating elements are powered by an on-board generator during vehicle operation and may also be powered by an external power source when the vehicle is not in operation.

In yet another aspect, a method for heating pavement repair materials in a hopper of a pavement repair vehicle includes providing at least one flameless heating element

in an air jacket adjacent to a hopper. The method also includes providing power to the flameless heating element using an on-board generator in order to heat hot mix asphalt within the hopper to a selected temperature range.

The present invention provides a number of important technical advantages. One important technical advantage is providing a flameless heating element that is powered by an on-board generator. This allows the pavement repair system to maintain hot mix asphalt at a desire temperature without the use of a flame-based heating system. Additional technical advantages will be readily apparent to those skilled in the art from the following FIGURES, descriptions and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present embodiments and advantages thereof may be acquired by referring to the following description taken in conjunction with the accompanying drawings, in which like reference numbers indicate like features, and wherein:

FIGURE 1 shows an existing pavement repair system with a propane heating system;

FIGURE 2 shows a perspective view of a hopper assembly with a flameless heating system for pavement repair system;

FIGURE 3 shows an end view of a hopper assembly with a flameless heating system;

FIGURE 4 shows a perspective view of a pavement repair assembly according to teachings of the present invention; and

FIGURE 5 shows an underside view of a pavement repair assembly according to teachings of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Preferred embodiments and their advantages are best understood by reference to FIGURES 1 through 5, wherein like numbers are used to indicate like and corresponding parts.

Now referring to FIGURE 1, an existing pavement repair system, sometimes referred to as a "pothole patcher" is generally depicted at 10. Pavement repair system 10 includes vehicle 12 with an insulated hopper 14 disposed thereon for transporting pavement repair materials, including hot mix asphalt. Hopper 14 includes an agitator 26 and screw conveyor 16 for urging pavement repair materials to exit hopper 14 through rear mounted chute 22.

When in use for hot mix asphalt application, hot mix materials must be maintained at a proper temperature. Existing system 10 utilizes a propane burner 20 during the operation of vehicle 12. Propane burner 20 heats oil 28 (stored within the walls of hopper 14) in order to heat hot mix asphalt materials in hopper 14. When vehicle 12 is not in operation for prolonged periods (such as overnight) hot mix asphalt materials in hopper 14 are heated by electric heater 18 that is powered by an external power source such as an external power outlet. As shown, existing system 10 also includes an on-board compactor 30 for use in pothole repairs.

The present invention improves upon existing mobile pavement repair or "pothole patcher" systems by using one or more electric heaters powered by an on-board generator.

Now referring to FIGURES 2 and 3, a perspective view and end view of a hopper assembly generally depicted at 50, with portions removed, are shown. Hopper assembly 50 includes a left side interior wall 52, a bottom trough 62 and a right side interior wall 54. As shown in this depiction, hopper assembly 50 further includes left side exterior wall 60 which forms an air jacket 58 adjacent to left side interior wall 52. A corresponding right side interior wall (not expressly shown) preferably forms a corresponding air jacket adjacent to right side interior wall 54. Hopper assembly 50 is preferably heated by first heating element 64 and second heating element 66 which are disposed in cradle support brackets 68 and provide heat within air jacket 58.

In the present embodiment, heating elements 64 and 66 are both electric heaters and eliminate the use of hot oil and the existence of propane flames. Preferably heating elements 64 and 66 are electric immersion heaters and may produce up to seven kilowatts or more of heat. More specifically, heating elements 64 and 66 may comprise 3.5 kilowatt tubular plug heaters having a length of approximately 105 inches and made of incoloy. In addition, heating elements 64 and 66 are preferably provided with ground fault protection to reduce the danger of electrical shock. The ground fault interrupter senses a ground fault and in turn, shuts the power off to prevent electrical shock to operating personnel.

Heating elements 64 and 66 are preferably inserted from the back of the hopper assembly 50 and are supported by brackets 68. The heaters are preferably secured using

a mounting ring and setscrews, or other suitable fasteners.

Heating elements 64 and 66 of the present invention heat air jacket 58 more uniformly than existing flame-based heating configurations. Heating elements 64 and 66 provide uniform heat to hopper assembly 50 and maintain the temperature of hot mix asphalt at a desired temperature using a thermostatic controller.

Hopper assembly 50 also preferably includes an agitator 26 and screw conveyor 16, as shown in FIGURE 1. Agitator 26 is preferably hydraulically driven and reversible. Screw conveyor 16 may preferably be a 6 x 6 screw conveyor that is hydraulically driven and reversible. Screw conveyor may also selectively provide enhances auger torque in order to work stiffer pavement repair materials such as cold mix.

Hopper assembly 50 is preferably mounted onto a vehicle 10 as shown in FIGURE 1. In the present preferred embodiment, hopper assembly has a capacity of approximately five cubic yards. Interior side walls 52 and 54 are sloped at 40° from vertical and the ends of hopper assembly 50 (not expressly shown) are sloped at 90°. Hopper assembly 50 has an air jacket 58 on the sides and bottom. Air jacket 58 is preferably insulated on the sides with approximately four inches of R12 rated insulation and on the ends with two inches of R12 rated insulation.

In some embodiments, materials within hopper assembly 50 are heated to a temperature range between 250° F and 350° F. In other preferred embodiments, hot mix

asphalt materials are maintained in the temperature range between 275° F and 300° F. The present hopper assembly may also be used with stockpile mix that may be warmed for better handling or with cold mix materials that do not require heating.

Hopper assembly 50 uses heating elements 64 and 66 for mobile and stationary heat. A hydraulically driven on-board generator (as shown in FIGURE 5) provides electricity for the heating system when pavement repair system is mobile. Power may be provided by an external power source, such as, for example, a 220-volt AC power outlet when the pavement repair system is parked. Accordingly, hopper assembly 50 may be loaded with hot mix asphalt materials late in the day and maintained at a desired temperature to be ready for use the following morning or when emergency repairs are needed. The invention also utilizes a ground-fault interrupter system (not expressly shown) for personnel safety.

Unlike currently pothole patcher systems, the present invention does not use a propane burner, retort tubes, or a heating oil circulation pump.

Now referring to FIGURE 4, a perspective view of a pavement repair assembly 68 for vehicle mounting according to teachings of the present invention is shown. As shown, pavement repair assembly 68 includes hopper body 50. Hopper body 50 includes left side exterior wall 60, a corresponding right side exterior wall (not expressly shown), a front end wall 88 and a rear wall (not expressly shown. Hopper body 50 further includes hopper doors 84. A direction arrow 86 may be mounted on

the rear portion of hopper assembly 50. Additionally, the present embodiment includes a rear spoils bin 82 disposed adjacent to the rear portion of hopper assembly 50. A side mounted spoils bin 92 (as shown in FIGURE 5) may also be included.

Pavement repair assembly also includes an air tank 72, cleaning fluid tank 74, hydraulic oil reservoir 76, hydraulic oil cooler 70, electric control box 78, and emulsion tank 80 mounted forward of hopper assembly 50.

Doors 84 are preferably double jacketed and insulated. Doors 84 are preferably opened hydraulically by a manually operated control valve.

Spoils bins 82 and 92 provide for improved accessibility and safety for collecting spoils. In the present embodiment bins 82 and 92 total approximately 1.2 cubic yards of waste storage space and feature a gravity dump. Further, the outside locations of these bins permit better maneuverability of and load distribution on the truck and easier user access than spoils bins mounted between the hopper assembly and the vehicle cab.

In the present embodiment, emulsion tank 80 provides an 80-gallon insulated tack coat tank to hold sufficient tack oil material for approximately one week of use. An average pothole typically takes relatively little tack oil material, thus tank 80 may be adequate for up to 700 potholes or more.

Emulsion tank 80 is preferably associated with an emulsion spray system (not expressly shown) including a two-in-one tack coat gun. The emulsion spray system is preferably operated by compressed air that is produced by the vehicle's air compressor. The two-in-one tack coat

gun can be used to blow out a hole or spray the tack coat material--a process which enhances productivity without the need for additional personnel or equipment. Compressed air is also used to return all tack coat material back to storage tank 80 when desired. Compressed air can also be used to stir the tack coat material in the storage tank 80.

In the present embodiment, external electrical heat is used to heat the tack oil tank, thereby eliminating the need for a retort tube or electric heating element inside the tank.

Cleaning system 74 is provided to allow tools and hopper assembly 50 to be cleaned. In the present embodiment, cleaning system 74 includes a sixteen gallon tank with a vented fill cap and tank isolation valve. Cleaning system 74 preferably includes a pump, a hose, and a spray wand.

In the present embodiment, pavement repair assembly 68 uses a 240 VAC single phase electrical system to provide power to heating elements 64 and 66. The power source is an onboard hydraulically driven AC generator for working hours (as shown in FIGURE 5) and a cable for an external source for non-working hours. The system is designed such that only one source can be used at a time.

In the present preferred embodiment, control box 78 includes a front panel having an AC generator power switch, a temperature controller, a voltmeter, and an AC current meter. The temperature controller is preferably a solid state thermostatic controller for controlling heating elements 64 and 66. In a preferred embodiment the controller features an LED readout of the actual

temperature of materials in hopper assembly 50 and the setpoint. A type J thermocouple may preferably be used as the feed back temperature reading to the controller. The thermocouple may be a ¼ X 7 inch adjustable type J thermocouple that generates its own millivoltage, which is read by the temperature controller. This millivoltage preferably corresponds to a given temperature known by the controller. In a preferred embodiment the thermocouple is located towards the rear of the hopper on the drivers side and when properly adjusted approximately one inch of probe extends from the compression nut it is mounted on.

The controller may also have an onboard diagnostic program to monitor the operation of the thermocouple and default to off if an error or problem occurs. In the present embodiment a 70 amp solid state is associate with the controller and is use to turn heater elements 64 and 66 on.

The control circuit is preferably protected by a 15 amp ground fault interrupt circuit breaker. Heating elements 64 and 66 may be protected by a 40 amp ground fault interrupt circuit breaker. This style of breaker is used for component protection and worker safety. In a preferred embodiment if either breaker detects more than 5 milliamperes between power and line neutral it will trip, shutting down the power to heating elements 64 and 66.

The voltmeter and an AC current meter may assist in monitoring the power and for troubleshooting. Control box 78 is preferably a NEMA 4, IP66 enclosure and may

include a key locking handle on the front to gain entry inside and for lockout protection during maintenance.

In some embodiments an AC generator excitation toggle switch may be included and may preferably be a single pole, 2 position maintained switch. In the on position such switch supplies power for the excitation of the generator (as shown in FIGURE 5).

In the present preferred embodiment, additional electrical components are provided behind the inside panel of control box 78. A 240 vac, 40 amp ground fault interrupt circuit breaker references the line current to neutral. If the current exceeds 5 milliamperes it trips the breaker. A 70 amp solid state relay is also included to turn on heater elements 64 based upon signals received from the temperature controller.

Additionally, control box 78 may receive from a 50 amp, four wire twist lock plug via an external power source such as during prolonged periods when the vehicle is not in operation.

The hydraulic system of the pavement repair assembly includes hydraulic oil reservoir 76 and hydraulic oil cooler 70. Hydraulic oil reservoir may preferably incorporate a vented filler cap, sight-temperature gauge, filter, and isolation valve. The hydraulic system is preferably powered by the power take off of the vehicle and have an off-on cab control. The hydraulic pump (not expressly shown) is preferably a variable volume type pump able to supply all power for hopper agitator 26, screw conveyor 16, and all other tools (aided by an automatic truck engine throttle control provides correct hydraulic flow on demand). Additionally, the hydraulic

system includes all necessary hydraulic lines, preferably having a minimum 2000 psi rating.

Now referring to FIGURE 5, an underside view of a pavement repair assembly 68 is shown. Pavement repair assembly includes side mounted spoils bin 92, rear chute 94, and compactor system 96. Compactor system 96 preferably may preferably include a vibratory type 5 hp compactor able to compact with 2475 lbs. force and having a 19 x 21 inch plate, or any other suitable compactor. The compactor is preferably mounted on a hydraulically activated platform.

Pavement repair assembly includes on-board AC generator 90. In one embodiment AC generator 90 is hydraulically driven at a suitable speed to produce 60 hz, providing 240 vac, single phase power with a maximum output rating is approximately 10 kilowatts with a continuous duty rating. In alternate embodiments, any suitable hydraulic generator may be used. Generator 90 may preferably be mounted on shock dampeners to provide for a quieter operation. In some embodiments a 12 vdc or 24vdc truck battery may be use for external excitation. In other alternate embodiments, generator 90 may be powered be belt driven from the crank shaft of the vehicle or may be powered by an auxiliary engine on board the vehicle.

In a preferred embodiment, a pavement breaker system (not expressly shown) is also included with pavement repair assembly. The pavement breaker system includes at least one 45 pound hydraulically powered asphalt chisel with a house and couplings for operation thereof.

In operation, the pavement repair system is loaded with hot mix asphalt. The hot mix asphalt is preferably maintained between 275° F and 300° F by heating elements 64 and 66. During vehicle operation, heating elements 64 and 66 are powered by on-board generator 90. When the vehicle is not in operation, heating elements 64 and 66 may be powered by an external power source, such as a power outlet, via a power cord connected with control box 78, which is operably coupled with heating elements 64 and 66.

The pavement repair assembly 68 (mounted onto an appropriate vehicle) is brought to an area of damaged pavement. First a traffic control area is established around the area to be repaired. Next, a marking line is made at least at least 750 mm (12 inches) into sound pavement surrounding the area to be removed. Weak and deteriorated pavement material is then removed so that the repair material has a firm surface to which it can adhere. Vertical cuts may then be made in the pavement to ensure the patching material has a good surface to bond to and is structurally supported by sound pavement. Loose material is then removed from the hole. Excess moisture in the hole can affect adhesion of tack coating or patching material. Brooming, blowing with pressurized air, or heating with a propane heater can be used to dry the hole.

Tack Coat promotes adhesion of the mix to the old pavement and should not puddle in the bottom of the hole. Excess tack coating may allow the patch to move. Where a

cold mix is used, tack coating is often not used since cold mix already contains thick asphalt films.

A 100 mm (4 in.) layer of patching mix is applied and compacted. To prevent pooling of water, the finished patch should not be lower than the surrounding pavement. In some operations, so called edge sealing is used to increase the ability of the patch to resist the entrance of water. This is done by applying a 150 mm to 200 mm (6 - 8 inches) wide strip of liquid asphalt along the perimeter of the finished repair. The liquid asphalt is then blotted with sand or aggregate chips.

Although the disclosed embodiments have been described in detail, it should be understood that various changes, substitutions and alterations can be made to the embodiments without departing from their spirit and scope